REMARKS

Claims 1-9, 11-14 and 17 are canceled. New claims 23-28 are added. Thus, claims 10, 15, 16 and 18-28 are pending. Claim 16 is an independent claim directed to a furnace, and claim 26 is an independent claim directed to a method. The remaining claims are dependent claims. New corrected drawings for FIGs. 1 and 2 are submitted, and independent claims 16 and 26 are submitted as being patentable over the references cited by the Examiner. No new matter was added. Accordingly, allowance of the present application is respectfully requested.

The format of this amendment corresponds to the "revised amendment format" suggested by the Deputy Commissioner for Patent Examination Policy, Steven Kunin, in an Internet posting on the web site of the U.S. Patent and Trademark Office dated January 31, 2003. According to the revised amendment format, a clean and marked up copy of the amended claims is not required. Rather, a complete listing of all the claims is required with "status identifiers" for all claims and markings (strikethrough and underlining) for currently amended claims only.

I. Drawings

In the Office Action, the Examiner objected to FIGs. 1 and 2 of the drawings and required the addition of a "prior art" legend. New corrected drawings of FIGs. 1 and 2 are submitted herewith and contain a "prior art" legend.

Applicants respectfully request approval of the corrected drawings and removal of the drawing objection.

II. Claim Rejections - 35 USC §112

In the Office Action, the Examiner rejected claims 10-15 for being indefinite.

Claims 11-14 have been canceled.

Claim 26 is the sole independent method claim. No new matter was added. See the application, as filed, on page 4, line 14, to page 5, line 8, and on page 8, lines 20-22.

Method claims 10 and 15 have been amended to be dependant from claim 26. New claims 27 and 28 are also dependent from claim 26. The subject matter of claims 27 and 28 are disclosed in the application, as filed, on page 6, line 26, to page 7, line 6.

Claim 16 is the sole independent apparatus (ie., furnace) claim. No new matter was added. See the application, as filed, on page 5, lines 9-27; page 8, lines 20-25; and page 9, lines 14-17.

Furnace claims 18-22 and new claims 23-25 are dependent from claim 16. The subject matter of claim 23 is disclosed in the application, as filed, on page 8, lines 13-15; the subject matter of claim 24 is disclosed in the application, as filed, on page 7, lines 21-30; and the subject matter of claim 25 is disclosed in the application, as filed, on page 12, lines 11-17.

Applicants respectfully submit that all pending claims are definite and are in compliance with 35 USC §112, second paragraph. Removal of the §112, second paragraph, indefiniteness rejection is requested.

III. Claim Rejections - 35 USC §102(b), (anticipation rejection)

In the Office Action, the Examiner rejected claims 1 and 10-17 under 35 USC §102(b) as being anticipated by JP 1-009823 of Kenji.

A prior art reference anticipates a claim if the reference discloses expressly or inherently all the elements and limitations of a claim. See Kalman v. Kimberly-Clark, 713

F.2d 760, 771, 218 USPQ 781 (Fed Cir. 1983). **Thus, even if one element or limitation is missing, a §102 rejection fails.** This requirement is both statutory and absolute as can be seen from the language of 35 USC §103 which states that:

> "A patent may not be obtained though the invention is not **identically disclosed or described as set forth in section 102** of this title, ..."

In the Office Action, the Examiner states that "Kenji teaches using a synthesis burner ...". Applicants respectfully disagree that Kenji teaches the use of a synthesis burner or the vapor deposition of synthetic silica by means of such a burner. Therefore, Applicants respectfully request reconsideration of the §102(b) anticipation rejection.

The Kenji reference only discloses a simple oxy-propane heater for use in heating and melting, or "quickly melting", particles (ie., "powdery silica stone or silica sand") fed from a hopper. For example, see the paragraph bridging pages 4 and 5 of the English translation of the Kenji reference. To this end, a starting powder material is fed to a burner from a hopper and is ejected into a furnace. "The material 6 is enveloped by the flame, heated and arrives at the silicic acid melting zone 8 of the furnace, and there completely melts." This description is completely incompatible with any notion that the burner of Kenji is a synthesis burner. Thus, the Kenji process is one of fusion, not synthesis. (See page 1, lines 1-2, of the present application, as filed, for a disclosure of a quartz glass made by a prior art process requiring fusion of powders similar to that disclosed by Kenji.)

In a synthesis burner, a combustible silica precursor material (such as siloxane, a silane or silicon tetrachloride) is entrained in the gases supplied to the burner and reacts in the flame projecting from the burner to produce micro-particles of silica. (See page 1, lines 13-22 of the present application, as filed.) Depending on the operating conditions, the micro-particles may be in the form of a fume or soot. Alternatively, according to the present

invention, the micro-particles are molten, are collected on a surface of a melt, and are incorporated into the melt by vapor deposition. Vapor deposition of synthetic silica by means of a synthesis burner is not disclosed by the Kenji reference and is significantly different to that of a fusion process disclosed by the Kenji reference.

Independent apparatus (ie., furnace) claim 16 of the present application requires a synthesis burner for depositing synthetic vitreous silica by vapour deposition onto a surface of the melt. The synthesis burner is also required to be supplied with a silica precursor. Independent method claim 26 requires depositing synthesis vitreous silica from a synthesis burner by vapor deposition onto a surface of the melt.

The Kenji reference does not disclose a synthesis burner, nor does it disclose depositing synthesis vitreous silica from a synthesis burner by vapor deposition. Thus, Applicants respectfully submit that independent claims 16 and 26 are patentable over the Kenji reference. The remaining claims of the present application are dependent directly or indirectly from one of the independent claims, and are submitted as being patentable over the Kenji reference for the same reason. Therefore, reconsideration and removal of the §102(b) anticipation rejection based on the Kenji reference is respectfully requested.

IV. Claim Rejections - 35 USC §103(a), (obviousness rejections)

In the Office Action, the Examiner rejects claim 18 under 35 USC §103(a) as being obvious over the Kenji reference in view of JP 64-003027 of Atsushi.

The Examiner cites the Atsushi reference for a disclosure of an arrangement of moveable clamps.

Applicants respectfully submit that the combination of the disclosures of the Kenji and Atsushi references does not disclose, teach, or suggest the present invention as claimed in

independent claims 16 and 26 of the present application. The recited combination of references fails to disclose the use of a synthesis burner for depositing synthetic vitreous silica by vapour deposition onto a surface of the melt, fails to disclose a synthesis burner supplied with a silica precursor, and fails to disclose the process step of depositing synthesis vitreous silica from a synthesis burner by vapor deposition onto a surface of the melt.

The Kenji and Atsushi references are both owned by Nippon Kokan KK of Tokyo, Japan and disclose processes for manufacturing a fused silica rod by melting silica in a refractory container and withdrawing the silica through a die to form a rod. The silica rods formed according to the Kenji and Atsushi references are crushed to a powder for use, for instance, as fillers for ceramic applications and the like.

An acknowledged problem with the apparatus and methods disclosed by these references is the adhesion of refractory brick material to the outer surface of the fused rod, as well as the possible inclusion of unmelted silica in the fused rod. (See, for instance, page 4, lines 5-12, of the English translation of the Atsushi reference.) These problems can be partially addressed by controlling the rate at which the rod is withdrawn so as to keep its surface temperature constant and by cracking off the exterior surface of the emerging ingot with a cold water spray. The nature of these remedies and of the problems they are intended to overcome are indicative of a field of endeavor very far removed from that of the present invention, which concerns the production of high quality glass for optical, optical fiber, semi-conductor or photomask applications.

The production of silica powder free from contamination by die-brick refractory materials and from unmelted crystalline materials are extremely basic requirements and cannot be compared to the highly stringent requirements for manufacturing substantial ingots of high quality glass for optical, optical fiber, semi-conductor or photomask applications,

which is the aim of the present invention and for which it is well known that a supreme optical quality is essential. Any conceivable possibility of inclusion of unfused silica or particles of refractory material is completely unacceptable. The mere possibility that such contamination may occur by utilizing the apparatus and process disclosed by the Kenji and Atsushi references, even at a reduced level, indicates quite clearly to one of skill in the art that the apparatus and methods described in those references are totally unsuited for use in the manufacture of ultra high purity glass.

Apart from the superficial similarity between the drawing technique of the present invention and that of the Kenji/Atsushi references, the processes involved are in fact vastly different. The Kenji/Atsushi references involve melting quartz sand granules typically at a temperature of 2,000 to 2,200°C in a furnace. (See related reference, JP 63-288906, cited in Applicants' previously filed IDS). This entails heavy thermal strain on the refractory and die materials, and consequently, substantial contamination of the emerging ingot. The process of the Kenji/Atsushi references is for the rapid bulk production of relatively low-grade vitreous silica. (For example, a related reference, JP 61-178415, discloses a throughput of 150 to 300 kg per hour). At such a high throughput rate, and operating at such high temperatures, the emerging ingot is bound to be laden with micro-bubbles formed by evolution of gases from impurities both on the surface and trapped within the silica grains being melted and by entrapment of gases in the interstitial spaces between adjacent grains as they rapidly fuse together. The ingot would in fact be opaque due these micro-bubbles, but this is no consequence to Kenji/Atsushi since the ingot is merely intended to be crushed to produce powdered vitreous glass.

In comparison, the present invention is capable of use at operating temperatures within a furnace of about 1,700 to 1,800°C and at throughput rates of about 2 kg per hour. It

is impossible to utilize operating temperatures of 1,700 to 1,800°C in methods according to Kenji/Atsushi which involve the quick homogeneous melting of silica sand. The resultant product of the present invention is an ultra-high purity optical quality glass that cannot be made according to Kenji/Atsushi.

Therefore, Applicants respectfully submit that the present invention would not be obvious to one of skill in the art that may be seeking to improve a system for producing ultra-high purity synthetic vitreous silica glasses and that was aware of the teachings of the Kenji/Atsushi references. For instance, the synthetic melt for making ultra-high purity optical quality glass according to the present invention would generate grossly excessive contamination when produced according to Kenji/Atsushi due to the difference in transparency between the melt of ultra-high purity synthetic vitreous silica glasses and that of Kenji/Atsushi. In addition, the amount of radiant heat loss from the emerging transparent ingot from the Kenji/Atsushi apparatus would entail such an increase in input energy in compensation that it would be impossible to maintain a sufficient rate of synthetic soot deposition on the surface of the melt. (In the Applicants' method, the amount of heat loss is in the range of about 25-30% of total heat input.) Of course, any increase in the rate of supply of combustion gases can lead to an increase in the proportion of silica soot undesirably expelled from the furnace with exhaust gases and a decrease in deposition efficiency. This is a serious problem because the collection of micro-particles of synthetic silica from a fast-moving vapor stream is an extremely delicate operation. The micro-particles migrate to the surface of the melt by a process of thermophoresis. This requires a stable laminar flow of silica-laden gas down onto the surface of the bath, and any substantial increase in the rate of supply of combustion gases is highly likely to disturb the process and lead to a reduction in deposition.

Thus, for any or all of the above stated reasons, one of skill in the art would not follow the teachings of Kenji/Atsushi to produce ultra-high purity synthetic vitreous silica glasses. In addition, it would not be obvious for one of skill in the art to produce ultra-high purity synthetic vitreous silica glasses based on the disclosures of the Kenji/Atsushi references.

Contrary to what might have been expected by one of skill in the art, the present inventors have invented a novel apparatus and method for producing ultra-high purity synthetic vitreous silica glasses. Unlike the Kenji/Atsushi systems, the system according to the present invention utilizes a synthesis burner for depositing synthetic vitreous silica by vapour deposition onto a surface of a melt within a furnace. The method can operate within a range of about 1,700 to about 1,800°C, which is much lower than that taught by the Kenji/Atsushi and related systems. As a result, the thermal loading on the refractory materials is relatively low, and the degree of contamination of the surface of the emerging ingot is within manageable proportions. It was also found to be possible, surprisingly, to maintain a sufficient rate of collection of synthetic silica soot (typically in the order of 2 kg per hour) to maintain constant operation, while permitting sufficient input energy to compensate for heat loss.

Therefore, for reasons discussed above, the apparatus and method claimed by independent claims 16 and 26 of the present application are not obvious and are patentable over the Kenji/Atsushi references. Reconsideration and removal of the §103(a) obviousness rejection of dependent claim 18 based on this combination is respectfully requested.

In the Office Action, the Examiner rejects claims 19-22 under 35 USC §103(a) as being obvious over the Kenji reference in view of the Atsushi reference and further in view of International Publication No. WO 97/10183 of Maxon.

The Examiner cites the Maxon publication for a disclosure of rotating/moving a crucible relative to a set of burners.

The Kenji/Atsushi references are discussed above in detail. The same arguments previously stated for non-obviousness and patentability of independent claims 16 and 26 of the present application also apply to the present rejection. The Maxon publication fails to disclose an apparatus or method for the continuous production of an ingot.

Therefore, for these reasons and the reasons previously discussed, the apparatus and method claimed by independent claims 16 and 26 of the present application are not obvious and are patentable over the combination of the Kenji, Atsushi and Maxon references. Reconsideration and removal of the §103(a) obviousness rejection of claims 19-22 based on this combination is respectfully requested.

V. Conclusion

Applicants have made a significant advance in the production of ultra-high purity synthetic vitreous silica glasses. Their invention is meritorious.

In view of the above amendments and remarks, Applicants respectfully submit that the rejections have been overcome and that the present application is in condition for allowance. Thus, a favorable action on the merits is therefore requested.

Please charge any deficiency or credit any overpayment for entering this Amendment to our deposit account no. 08-3040.

Respectfully submitted,
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